Fluid-Structure Interaction Modeling of Artery Aneurysms with Steady-State Configurations

Eugenio Aulisa†, Giorgio Bornia* and Sara Calandrini†

* Department of Mathematics and Statistics
Texas Tech University
Lubbock, TX 79409, USA
e-mail: giorgio.bornia@ttu.edu

† Department of Mathematics and Statistics
Texas Tech University
Lubbock, TX 79409, USA
e-mail: eugenio.aulisa@ttu.edu, sara.calandrini@ttu.edu

ABSTRACT

This paper addresses numerical simulations of fluid-structure interaction (FSI) problems involving artery aneurysms, focusing on steady-state configurations. Both the fluid flow and the hyperelastic material are incompressible. A monolithic formulation for the FSI problem is considered, where the deformation of the fluid domain is taken into account according to an Arbitrary Lagrangian Eulerian (ALE) scheme. The numerical algorithm is a Newton-Krylov method combined with geometric multigrid preconditioner and smoothing based on domain decomposition. The system is modeled using a specific equation shuffling that aims at improving the row pivoting. Due to the complexity of the operators, the exact Jacobian matrix is evaluated using automatic differentiation tools. We describe benchmark settings which shall help to test and compare different numerical methods and code implementations for the FSI problem in hemodynamics. The configurations consist of realistic artery aneurysms. A case of endovascular stent implantation on a cerebral aneurysm is also presented. Hybrid meshes are employed in such configurations. We show numerical results for the described aneurysm geometries for steady-state boundary conditions. Parallel implementation is also addressed.

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